Mr. Aitken puts this principle in a very clear light, as follows:

What is generally called a saturated vapor is one whose tension is equal to the tension of the vapor at a flat surface. Now this tension is not so high as the tension at a surface of extremely small convex curvature; and vapor that is in equilibrium with the vapor at a convex surface is supersaturated with reference to that at the flat surface; so that saturation is a relative and not an absolute quantity, relative to the curvature of the condensing surface, and a vapor that is supersaturated to a flat surface is not necessarily saturated to a surface of very small curvature. It would thus appear that there is no strain in a vapor till a surface makes its appearance, but after *it* is formed the lower tension at this surface determines a movement of the vapor molecules toward it. * * * From this way of considering the subject it would appear that there is no such thing as supersaturation in a pure vapor free from nuclei, consequently no strain in the vapor that needs to be relieved.

The figures for vapor tension, considered as a meteorological datum, should, of course, always be considered as reduced to the normal value for a flat surface, but this is only important for surfaces of very small curvature.

CYCLES IN METEOROLOGY.

The important and laborious computations by Mr. Dallas, the officiating meteorological reporter for the Government of India, as published in full in the current number of the MONTHLY WEATHER REVIEW, do not encourage further efforts to discover arbitrary cycles that are likely to be of importance either to meteorology or to the weather forecaster. If one had a myriad of observed temperatures, pressures, or rainfalls he could apply the harmonic analysis and represent the whole set of values accurately by a series of cycles, but every new observation of pressure, etc., would require the addition of a new cycle or the modification of an old one to represent it. The computations of Mr. Dallas have resulted in showing that an 11-year plus a 9-year cycle does not enable us to determine beforehand, with any certainty, the probable amount of the total annual rainfall. There are, of course, numerous coincidences between cyclic predictions and actual rainfall, but the frequent outstanding discrepancies are such as to rob the predictions of all real value. As with rainfall so with pressure; the departures of mean annual pressure from a uniform normal value are so small that we find ourselves discussing arbitrary cycles whose amplitudes are matters of 0.008 or 0.010 inch of pressure; these small quantities are at the very limit of the accuracy of our observations. If we apply the method of least squares to the differences between the observed and the computed values, we shall only arrive at a proper appreciation of the extrinsic but not of the intrinsic value of the cycles.

Arbitrary cycles are only resorted to when we have no clew to the rational connection between the phenomena and their ultimate causes. But the study of the motions of the earth's atmosphere has progressed far enough, both from an observational and a theoretical point of view to justify a determined effort to establish long-range forecasts of seasonal rainfall upon a higher plane than that of purely arbitrary cycles. Such higher methods may be empirical, but they are not necessarily arbitrary; they may be numerical and special, rather than analytical and general, but they may still be based upon a rational consideration of the mechanics of the atmosphere.

The laws of the mechanics of fluids show that there must be many temporary periods or cycles. Thus, for instance, if there are changes in the intensity of solar radiation, there must be corresponding immediate changes in the temperature, moisture, pressure, and motions of the atmosphere. Every such change of insolation will be perceived for a long time, possibly many years after its occurrence, by the existence of subsidiary phenomena that will spread over the entire globe until the whole influence of the change has permeated the atmosphere uniformly and the periodicities have died away.

On the other hand, without any change in solar or cosmic influences, but simply by reason of the production of rythmic changes as to pressure and wind within the atmosphere itself, the influence of that which is happening to-day in one region may be felt years hence far away. It other words, it is not necessary to go outside of the atmosphere to look for the origin of cycles and other less regular changes. The study of the droughts of recent years in the Southern Hemisphere (when elucidated by the study of a daily map, or even of a monthly summary of the conditions over the whole globe, and when interpreted by the general principle that rainfall at any locality depends directly upon the wind below and the currents above) shows why the drought of the South Pacific slowly advanced, month after month, northeastward into America, and eventually died away over Europe. The relation between the meteorology of Mauritius and that of India, as studied by Mr. Dallas, or the relation between India and the distant southern Indian Ocean, as studied by Mr. Eliot, or the relation between Australia and the South Pacific, on the one hand, and that of Hawaii and the North American Continent, on the other, as recently referred to by the Editor, is determined by the so-called general circulation of the atmosphere. This latter has certain broad features that result from the interaction of those portions of the atmosphere that are above the continents and the polar regions, upon those other portions that are above the oceans and the equatorial regions.

In seasonal predictions for large regions the general movements of the atmosphere and certain general principles in physics must be borne in mind. Consider first the connection between rainfall and the clouds. As a general rule, the lower the clouds the greater the chance that rain will fall from them. Now, the height of a cloud depends somewhat upon the method of formation. If the wind is blowing against a mountain side, the resulting cloud and its rain are due, primarily, to the dynamic cooling of expanding air; the height of the cloud will depend upon the dew-point and temperature of the air; the quantity of rain at any spot on the mountain will also depend upon the strength and persistency of the wind. This class of rains is well illustrated by the perpetual cloud and drizzle due to west winds on the summit of Pike's Peak or to the southeast trades on the summit of Green Mountain on the Island of Ascension, and also by the heavy rainfall during the southwest monsoon season on the windward side of the Ghats, and frequently also, of the Himalayas in India. On the other hand, when a warm wind is pushed aside and lifted up by an underflowing colder wind, as happens at the front of our "northers" and northwesters, we have not merely dynamic cooling due to ascent, but a still further cooling and, also, a drying due to the mixture of the two layers of air; the resulting clouds are colder because of this mixture, and the rainfall is less not only for this reason, but also because the mass of warm air and clouds is pushed forward, and is very soon entirely replaced by the advancing dry, cool, clear air. In general, clouds formed even partially by mixtures give little rain, but those due only to expansion give generous rain. The drizzles and daily showers from mixtures may, however, be very important to agriculture.

Consider now the layer of air next above the lowest. After the lower current has left a little rain on the windward side of a mountain range, it partially recurves as an overflow upon itself. The relative amount of the overflow depends upon the speed of the current and its depth as compared with the height of the mountain range. When that depth is considerably greater than the height of the obstacle the main part of the current goes on beyond the range as an upper current over the continent, descending here and there to the earth's surface. All that portion of the continent that is under the influence of this descending wind is subject to dry, warm fœhn winds, and, at the best, relatively light rains. If the lower current on the windward side of the range is relatively feeble and but little rain is deposited on the windward side, then but little wind will flow thence over the continent, the volume of the descending dry fœhn winds will diminish, and the chances for local rains in the interior will increase.

In general, the quantity and frequency of rain depends upon the heights of clouds whose very formation itself depends upon the upper and lower winds. The absolute quantity of rain depends, also, upon the dew-point, and, other things being equal, is, therefore, greater for moist winds than for dry; but the relative quantity and the relative frequency of rain in successive seasons are the features that determine a drought, in ordinary agricultural usage, for any locality, and these depend essentially upon the relative movements of the atmosphere in the respective seasons. If the movements are downward, or feebly upward, or if they introduce cooler or drier air than usual, the result is drought; if they are more strongly upward than usual, they bring cloud and rain. These principles are abundantly illustrated by the winds and rains that prevail in the interior of India, Australia, and North America.

WATER MEASUREMENTS FOR IRRIGATION.

The attention of the Editor has been called to the fact that on page 209 of the MONTHLY WEATHER REVIEW for May, 1897, he has adopted the British Imperial gallon, which is used in many parts of this country, and has said nothing about the British wine gallon, which is also used. The imperial gallon contains 10 pounds of water, or 277.274 cubic inches. The wine gallon contains 8.3389 pounds of water, or 231 cubic inches. Records expressed in imperial gallons may be converted into wine gallons by multiplying them by the factor 10/8.3389 or 1.21.

CHINOOKS IN IOWA.

If the term "fœhn wind" is to be used as a general name for all warm, dry, descending winds then, of course, there may be a similar propriety in the use of the word "chinook," but as "fœhn" has the priority of many years of meteorological usage, and as we have both dry chinooks in Montana, and wet chinooks in Oregon and Washington, the Editor would prefer the unambiguous Swiss or Helvetian word "fœhn."

The Climate and Crop Report from Iowa for the month of December contains two interesting notes by observers. At Clarinda, A. S. Van Sandt says:

> On the morning of the 29th the wind was in the northwest, soon veering to west. It was as mild as May and reminded me of what I have read of the chinook. Query: Was it the tail end of one? The snow, which was very compact from previous melting, lost one-third of its depth.

At Odebolt, E. Starner says:

> December 4.—Chinook at midnight that settled the snow about 6 inches.

Before studying the weather maps to ascertain whether conditions were favorable for descending winds on these dates, the Editor would say that, in general, such winds may occur at any spot on the globe. The fact that they are peculiarly frequent and effective in certain regions, such as Switzerland, Greenland, western Montana, New Zealand, and northern India should not prevent us from recognizing the fact that they are recurring frequently in almost every other region. Whenever some air ascends other air must descend. There can be no doubt but that the famous hot winds that occur occasionally from Texas northward to Canada are descending winds.* It is scarcely proper to speak of the fœhn wind in Iowa as the tail end of a chinook that had spread from Montana down to that State, because both these terms are generally more restricted in extent. The hot winds of Iowa and of Montana are generally separate local chinooks.

On examining the weather maps for December 4 and 29, we find that on the morning of the 4th the temperature had risen remarkably in western Nebraska, eastern Wyoming, and northward through Dakota and Montana into Canada. The winds were from the southwest, the air was descending the eastern Rocky Mountain Slope, the pressure was 30.70 over the region around Salt Lake City, and 29.70, or less in Manitoba, everything was favorable for a chinook in the intermediate regions. By the 5th, a. m., the warm winds had covered a large region southeastward to the Mississippi Valley. Evidently the whole mass of air flowing eastward from the region of high pressure was descending along the surface of the ground and did not begin to rise until it came within the influence of the low pressure near the Lake Region. On the 4th, a. m., at Havre, Mont., the temperature was 56° higher than on the 3d, a. m. This was an intense chinook. Iowa had temperatures 12° or 14° higher, and during the whole day experienced a moderate chinook. All the intermediate regions had their descending dry and relatively warm winds.

On December 29 the conditions were very similar. The high pressure was over the Salt Lake region; the lowest pressure was over Lake Superior; the whole eastern Rocky Mountain Slope was covered with a layer of descending air, clear and dry, and, in general, warmer to such an extent that Iowa, Minnesota, and Wisconsin were from 20° to 50° warmer than on the 28th. The chinook—if it may be so called—prevailed from the Rocky Mountains eastward to the Mississippi. Iowa did not get the tail end of it but was in the midst of it.

If "chinook" and "fœhn" are terms that are to be restricted to intense local manifestations of descending winds, and if by the "hot winds" of the western plains we designate only those that occur at the time of the ripening of the wheat and corn, when they do such injury to crops, then we ought perhaps to devise some term specifically appropriate to these widespread areas of descending winds that bring dry, clear, warm weather to one-half of the Mississippi watershed.

Not only does the eastern slope of the Rocky Mountain region have its descending chinook winds, but so also has the eastern slope of the Appalachian range, a fact that was pointed out by the Editor as long ago as 1872. The westerly winds that bring fog and possibly rain or snow to Buffalo, Pittsburg, Knoxville, and Chattanooga frequently descend upon New York, Washington, Lynchburg, Columbia, S. C., and Atlanta as clear dry winds, and on the average a very little warmer than on the windward side of the mountain range. One of the first indications of this action of descending winds was observed soon after the station at Lynchburg was opened in 1871, when it was found that so-called clearing up weather and the first clear sky began at that station some hours before it reached Washington, and even a whole day earlier in the case of very slowly moving changes.

An area of high pressure apparently represents a region in which air is descending so slowly to the earth's surface that it cools by radiation faster than it warms up by compression. When such an area is central, as occurred so frequently during December, over the middle Plateau Region, the atmosphere is pushed not merely eastward down the eastern slope, but also northwestward into California, Oregon, and Washington. It is the relatively rapid descent down these slopes that causes the air, which is compressed by its own

*See the article "Summer Hot Winds on the Plains," by Dr. I. M. Cline, Weather Bureau Observer, in the Bull. Phil. Soc. Washington, XII, 1894.